Work-Related Injury Frequency Rates in the Navy Seabees

Thesis
V162526

by

James R. Van de Voorde

Submitted in partial fulfillment of the
requirements for the degree of

Master of Science in Civil Engineering

University of Washington

1991

Work-Related Injury Frequency Rates in the Navy Seabees

by

James R. Van de Voorde

Submitted in partial fulfillment of the requirements for the degree of

Master of Science in Civil Engineering

University of Washington

1991

T253526

Thesis
V 162526
C. 1

TABLE OF CONTENTS

Page

List of Tables....ii

Section 1. INTRODUCTION....1

Section 2. BACKGROUND ON SEABEES....3

Section 3. RESEARCH METHODOLOGY....6

Section 4. RESULTS....10

Part A: Overall Characterization of the Data....10

Part B: Jobsite Workers....18

Part C: Independent Factors....20

Section 5. SUMMARY AND RECOMMENDATIONS....32

BIBLIOGRAPHY....35

APPENDIX A: Questionnaire....36

APPENDIX B: Histograms of Jobsite Seabees Frequency of Injuries.40

APPENDIX C: Supervisor Correlation Tables....43

APPENDIX D: Definition File....45

LIST OF TABLES

Page

Table 1. Responses by Trade....11
Table 2. Responses by Paygrade....11
Table 3. Responses by Job Description....11
Table 4. Injury Frequency....17
Table 5. Responses by Trade for Jobsite Seabees....19
Table 6. Responses by Paygrade for Jobsite Seabees....19
Table 7. Injury Frequency Rates for Jobsite Seabees....19
Table 8. Injury Frequency Rate by Trade for Jobsite Seabees....21
Table 9. Injury Frequency Rate by Time at Present Command for Jobsite Seabees....22
Table 10. Injury Frequency Rate by Time in the Navy for Jobsite Seabees....23
Table 11. Correlation Between Supervisor Variable and Injury Frequency Rates....26
Table 12. Correlation Between Worker Comfort Variable and Injury Frequency Rates....27
Table 13. Correlation Between Assistance Variable and Injury Frequency Rates....28
Table 14. Correlation Between Morale Variable and Injury Frequency Rates....28
Table 15. Correlation Between Safety Lecture Variable and Injury Frequency Rates....29
Table 16. Correlation Between First Aid Case Injury Rates and Internal Personal Factors....31

SECTION 1: Introduction:

Worker safety is a solemn responsibility of all leaders and managers. Understanding what safety statistics indicate is only the beginning of this responsibility. Leaders must be intimately familiar with the safety records of their organization and be able to identify the key areas that pose the most risk to their workers. A successful safety program certainly includes the enforcement of specific safety standards. However, management often delegates the safety function to a special staff or division. The role that top management plays in creating a safe work "environment" is often overlooked. This "environment" includes not only the physical hazards but also the organization's overall policies and leadership styles. A "safe" organization therefore must have more than a safety committee meeting every month, or a broad organizational policy statement on safety or even consistent enforcement of safety regulations, i.e., it must create as integral to its overall management plan, a positive atmosphere within which good safety programs (consisting of the above elements) can operate.

Workers in the construction industry face significant hazards to their safety and well being. While making up only 6% of the U.S. domestic work force, construction workers account for 21% of worker fatalities and 11% of all serious injuries (National Safety Council, 1990). Construction worker safety is not limited to the civilian world. The armed forces of the United States employ on active duty tens of thousands of construction workers. This paper will focus on a

particular group of construction workers in the armed forces, the Navy Seabees. These men and women of the famed Seabees perform many of the same trades that are found in the civilian construction industry.

A recent study by Navy Lieutenant Timothy Burns (University of Washington, 1990) addressed construction productivity among Navy Seabees. His survey of over 600 Seabees also gathered data on safety factors and injury frequencies. This paper will describe additional analysis of that data that was performed with the following four objectives in mind:

- Determine average injury frequency rate for Seabees
- Identify groups within the Seabees that have the highest injury rates
- Identify other factors that most affect injury rates
- Make recommendations based on these findings for inclusion in leadership and safety training

SECTION 2: Background Information on Seabees

The following background on Seabees is provided to help the reader understand the results. The Navy Seabees questioned in this study are enlisted personnel skilled and trained in construction. Seabees enter the Navy following high school and often have little or no construction experience. Upon completion of Navy basic recruit training or "boot camp", all Seabees attend an entry level training course ("A" School) applicable to their speciality. These schools are generally 12 to 16 weeks in length. Construction Electricians complete 4 weeks of basic electrical theory course work prior to their "A" school.

The seven Seabee trades, called "ratings", encompass all construction trades. Therefore, Seabees do not become specialists instead they are often cross-trained in other construction skills since their jobs may carry them to remote locations where more than one skill is required to carry out their mission. The seven ratings and areas of expertise are:

•Builders. These Seabees perform as carpenters, working with wood and concrete; as masons and as painters.

•Steelworkers. Steelworkers fabricate and erect steel structures, bend and install reinforcing steel, weld most metals and bend sheet metal, including ventilation duct work fabrication and installation. They also are skilled in rigging methods and techniques.

•Engineering Aides. "EA's", as they are known, perform drafting and minor design work, surveying and materials sampling and testing.

•Construction Electricians. These Seabees install and service exterior high voltage power distribution systems, operate mobile power generators, install interior electrical wiring and motors and maintain telecommunication systems.

•Utilitiesmen. Utilitiesmen install and service mechanical systems, interior and exterior water and wastewater lines, and maintain HVAC control systems. They also operate water and wastewater treatment facilities and refrigeration systems.

•Equipment Operators. "EO's" are the heavy equipment operators driving vehicles from light vans to graders to boom cranes. They also operate rock quarries, concrete and asphalt plants, conduct blasting operations and drill water wells.

•Construction Mechanic. These Seabees maintain and service all automotive, material handling and construction equipment in addition to electrical power generators and small gas-powered tools.

The two Seabee units surveyed were Naval Mobile Construction Battalions (Battalions) and Construction Battalion Units (Units). The Battalions each have approximately 500 Seabees as well as 100 non-construction trained support personnel such as clerks, cooks and storekeepers. Members of Battalions are trained to be mobile and regularly deploy to overseas sites in Europe, the Caribbean, and the Pacific. Their primary mission is military construction support in wartime. Thus most facilities built by Battalions are of a more temporary nature. Their skills are also readily used in disaster

recovery and humanitarian assistance missions. It is important to note that all Seabees are trained to carry out their mission under wartime conditions. To accomplish this, Seabees regularly train in defensive combat operations.

The Units are permanently assigned to a specific naval base, hence they do not deploy unless needed in wartime. These units are much smaller, with only 40 to 50 personnel assigned to each Unit. However, they mirror their larger sister battalions in types of projects, and other training conducted.

Women also serve in the Seabees, in all ratings, however, current policy prevents them from serving in the Battalions because of combat risk rule exclusions. They are assigned to other Seabees commands in the United States such as the Units as well as on overseas bases.

SECTION 3: Research Methodology:

The data used in this current study was gathered by Lieutenant Burns (University of Washington, 1990). The method used to collect the data was a mail survey. Questionnaires were sent to the eight active duty Battalions and to eight smaller commands, called Units. 1000 questionnaires were distributed: 100 each to the Battalions and 25 each to the Units. A total of 618 responses were received. The principle focus of Lieutenant Burns' research was to identify primary motivational and productivity factors among Seabees. There were however also 6 questions regarding worker safety:

1. **Do safety regulations restrict your ability to work effectively?**
2. **Do you understand the need for safety awareness on the projects?**
3. **Do you feel that you work in a safety conscious work environment?**
4. **Are daily safety lectures effective?**
5. **Have you observed any major safety violations that were unreported?**
6. **Since you have been in your present unit/command, how many injuries have you received that:**
    a. **Required first aid treatment only?**
    b. **Required a doctor's attention?**
    c. **Were lost time accidents?**

Questions 1 through 5 were answered by choosing one of six responses:

(1) to a very little extent

(2) to a little extent

(3) to some extent

(4) to a great extent

(5) to a very great extent

(6) not applicable

The current research concentrated on the responses to these 6 questions to provide the basis of analysis. Therefore, the dependent variable for this study was safety performance, or more specifically, injury frequency rates. The original questionnaire is included in Appendix A.

Injury rates were calculated in units of the number of injuries per million worker hours of exposure. Injuries were classified by three levels of severity:

- injuries requiring first aid on the jobsite (called First Aid Injuries)
- injuries requiring off site doctor treatment (Medical Case Injuries)
- injuries resulting in lost workdays following the day of the injury (Lost Time Injuries)

In addition to determining the injury frequency rates, other independent variables or factors were then analyzed to determine the extent to which they correlate with injury rates. Examples of independent variables include: supervisor relations, paygrade of the worker, time in the present command, etc.

The survey responses provided information on the number of each type of injury suffered while at the present command, how long the worker has been at the present command, and the number of hours in an average workweek (determined to be 49.2 for the Battalions and 41.9 for the Units). It was assumed that each Seabee worked 48 weeks each year as service members are entitled to 30 days of "leave" or vacation each year. The injury frequency rate was determined by the following formula:

Rate in injuries per million worker hours of exposure = (number of injuries while at present command) *times* 1,000,000 hours per million worker hours *divided by* (number of years at present command *times* 48 weeks per year *times* the hours worked each week). For example, a Seabee assigned to a Unit had two injuries in 12 months at the Unit. This translates to an injury rate of 994 injuries per million worker hours of exposure (2 x 1,000,000)/(1 x 48 x 41.9).

Statistical analysis was conducted assuming normally distributed data. The specific computer software utilized was "Statistical Package for the Social Sciences" or SPSS. This is the same program used in Lieutenant Burns' study. In addition to basic frequency and mean calculations, both rank correlation and multiple linear regression analyses were used to determine the relationships, if any, between injury rates (the dependent variable) and other independent variables provided by the survey responses.

Independent Factors

The independent variables or factors can be grouped into three broad categories. The first is personal data, consisting of the following specific factors:

- worker trade, called rating in the Seabees
- pay scale level, referred to as paygrade
- tenure of the Seabee in the Navy
- tenure of the Seabee in the present command
- position of Seabee; either a project manager, crew member or leader or staff/support
- organization type; either a Battalion or a Unit

The second category of independent factors were those relating to productivity:

- crew and fellow worker relations
- tools and equipment used
- substance abuse
- communication
- relations with supervisor
- location of work
- stress
- training provide
- personal problem
- physical fitness
- type of work

The third factor category were motivational factors including:

- rewards
- benefits
- recognition
- camaraderie
- job security
- advancement
- money
- personal goals
- job satisfaction

SECTION 4: Results:

The results of this paper are presented in three sections. First, an overall statistical presentation of the data will be given. This includes responses to the five opinion type questions as well as average values for the three injury rates. The next portion of this section will focus more closely on the jobsite workers as a group. An analysis of the injury rates for these jobsite Seabees will be presented. Finally, the results section will present results from the correlation and regression analysis, analyzing the independent factors influencing injury rates. All injury frequency rates are expressed in the number of injuries per million worker hours of exposure.

Part A: Overall Characterization of the Data

There were 618 valid responses in the data: 495 or 80.1% were from seven reporting Battalions and the remaining 123 or 19.9% were from six Units. The average Seabee had spent just over six years in the Navy and almost 17 months at the present command. Tables 1 and 2 breakdown the responses by trade and paygrade (E1 being the most junior and E9 the most senior). Table 3 shows the breakdown by job description or position.

Table 1
Responses by Trade

Trade	Frequency of Response	Percent
Builder	188	30.4
Steelworker	62	10.0
Construction Electrician	68	11.0
Utilitiesman	66	10.7
Equipment Operator	117	18.9
Construction Mechanic	86	13.9
Engineering Aide	29	4.7
No Response	2	0.3
Totals	618	100.0%

Table 2
Responses by Paygrade

Paygrade	Frequency of Response	Percent
E1	25	4.0
E2	70	11.3
E3	98	15.9
E4	163	26.4
E5	129	20.9
E6	91	14.7
E7	22	3.6
E8	10	1.6
E9	7	1.1
No Response	3	0.5
Totals	618	100.0%

Table 3
Responses by Job Description

Job Description	Frequency of Response	Percent
Project Manager	41	6.6
Crew Leader	134	21.7
Crew Member	282	45.6
Staff or Support	112	18.1
Other	41	6.6
No Response	8	1.3
Totals	618	100.0%

Opinion Questions and Responses

The five opinion questions involve each Seabee's opinion of current safety related issues. The numerical values correspond to the following responses:

(1) to a very little extent
(2) to a little extent
(3) to some extent
(4) to a great extent
(5) to a very great extent

1. Do safety regulations restrict your ability to work effectively?

Based on 545 responses, the mean answer was 2.70, thus between to a little extent and to some extent. The responses were then broken down by position as shown below:

Position	Number	Mean Value
Project Manager	39	2.95
Crew Leader	133	2.64
Crew Member	270	2.87
Staff/Support	103	2.35

Of all the positions, the most senior, the project managers, showed the highest agreement that safety regulations restrict the ability to work effectively. The responses were also broken down by trade, as shown below:

Trade	Number	Mean Value
Builder	176	2.99
Steelworker	59	2.86
Construction Electrician	66	2.65
Utilitiesman	63	2.60
Equipment Operator	108	2.72
Construction Mechanic	84	2.35
Engineering Aide	29	1.90

The engineering aide had the lowest rating response, which is logical since as draftpersons and surveyors, safety regulations do not affect their work to the same degree as the other trades. The builders, or carpenters, had the strongest rating response regarding the safety regulations.

2. Do you understand the need for safety awareness on projects?

Based on 553 responses, the mean response was 4.48, pointing out that there is great to very great awareness for the need of safety on projects. The responses were then broken down by position as shown below:

Position	Number	Mean Value
Project Manager	40	4.70
Crew Leader	132	4.54
Crew Member	275	4.40
Staff/Support	106	4.56

It is interesting to note that the crew members had the lowest agreement as to the need for safety awareness, when they are probably the group most at risk to jobsite hazards. Thus while the overall responses indicate a strong sense of safety awareness, the relative answers could indicate that additional education and training

are required for crews. The responses were also broken down by trade, as shown below:

Trade	Number	Mean Value
Builder	182	4.42
Steelworker	61	4.52
Construction Electrician	68	4.41
Utilitiesman	66	4.56
Equipment Operator	111	4.50
Construction Mechanic	82	4.56
Engineering Aide	28	4.53

All seven trades were very close in their response ratings regarding safety awareness, which could indicate that the current training is successfully reaching all Seabee trades. The Construction Electricians had the lowest score on this factor, but this was only by a small margin.

3. Do you feel that you work in a safety conscious work environment?

Based on 559 responses, the mean response was 4.06 indicating that to a great degree, Seabees feel they work in a safe environment. The responses were then broken down by position as shown below:

Position	Number	Mean Value
Project Manager	40	4.48
Crew Leader	133	4.02
Crew Member	275	3.99
Staff/Support	111	4.04

Again, the group most at risk on the jobsite, the crew members, had the lowest mean response.

The responses were also broken down by trade, as shown below:

Trade	Number	Mean Value
Builder	184	4.14
Steelworker	61	4.13
Construction Electrician	68	3.81
Utilitiesman	66	4.06
Equipment Operator	111	4.02
Construction Mechanic	85	4.06
Engineering Aide	29	4.14

Of all the trades, the construction electrician had the only mean value below 4.00 indicating the least secure feeling of safety on the jobsite. Electricians know that accidents or mistakes in their line of work can be fatal. Thus, their response could be indicative of their particular trade. It is interesting to note however, that this trade had the lowest opinion of the need for safety awareness on question 2. The builders on the other hand, while answering earlier that regulations restrict their work do show that they believe they work in a safe environment.

4. Are daily safety lectures effective?

Based on 546 responses, the mean was 3.39 indicating that between to some and to a great extent that the daily safety lectures conducted by the commands are effective. The responses were then broken down by position as shown below:

Position	Number	Mean Value
Project Manager	39	3.95
Crew Leader	132	3.31
Crew Member	269	3.30
Staff/Support	106	3.48

These values appear significantly lower than earlier responses indicating while the lectures are considered effective, there is less satisfaction in this area than the others. Again, the crew members had the lowest satisfaction with these safety lectures. The responses were also broken down by trade, as shown below:

Trade	Number	Mean Value
Builder	177	3.33
Steelworker	60	3.48
Construction Electrician	67	3.16
Utilitiesman	65	3.43
Equipment Operator	108	3.59
Construction Mechanic	83	3.35
Engineering Aide	26	3.38

The equipment operators had the highest opinion of the lecture effectiveness, while again the electricians had the lowest.

5. Have you observed any major safety violations that were unreported?

Based on 489 responses, the mean value was 2.07 indicating that Seabees questioned had observed major safety violations that went unreported to a little extent. The responses were then broken down by position as shown below:

Position	Number	Mean Value
Project Manager	37	1.67
Crew Leader	118	2.11
Crew Member	239	2.28
Staff/Support	95	1.77

These responses appear logical, that the personnel on site more often would have the opportunity to observe a major safety violation,

although it is encouraging that the values are as low as they are. The responses were also broken down by trade, as shown below:

Trade	Number	Mean Value
Builder	158	1.97
Steelworker	52	1.98
Construction Electrician	62	2.17
Utilitiesman	58	2.13
Equipment Operator	102	2.37
Construction Mechanic	77	1.80
Engineering Aide	20	2.00

The equipment operators had the highest value for observing safety violations, and yet they also had the highest opinion of the effectiveness of daily safety lectures. It is possible that they believe the heavy equipment lectures are effective and they think other trades around them allow major violations to go unreported. The construction electricians again gave a higher rating response. Combined with earlier questions, this appears to indicate a weakness in the safety knowledge and training among the electricians.

Injury Frequency Rates

The overall injury frequency rates for the 618 cases are depicted in Table 4.

Table 4
Injury Frequency Rates

Injury Type	Number	Injury Rate
First Aid Case	614	608.7
Medical Case	603	368.8
Lost Time Case	585	132.8

The injury rate decreased with the increased severity of the injury. It was postulated that the different positions held by the Seabees (e.g. project manager or crew member, etc.) could result in different exposures to jobsite hazards. This would affect the overall injury rates shown above. Generally speaking, the crew leaders and crew members are the primary jobsite workers while the project managers, and staff and support personnel have much less exposure to jobsite hazards. Based on a breakdown of the injury rates by worker position, the crew members had the highest medical case and lost time case injury rates compared to the other positions. Strangely, the position of project manager had the highest first aid injury rate (1682 injuries per million worker hours of exposure). However, this rate was based on only 26 cases including one with an extreme injury rate of 30,864. Without that one case, the project manger's injury rate would have been lower than the crew member's rate. Since the focus of this research is on *jobsite* worker safety, it was determined that the only data used for the rest of the study would be for the positions of crew leader and crew member. There were 410 valid cases in this data set.

Part B: Jobsite Worker Results

Of the 410 cases, 326 (79.5%) were from the Battalions and 84 (20.5%) were from the Units. Of this group, the average Seabee had almost 16 months at the present assignment and 4.5 years in the Navy total. The distribution by trade is shown in Table 5, the breakdown by paygrade is shown in Table 6 and the breakdown by injury frequency rate is shown in Table 7.

Table 5
Responses by Trade for Jobsite Seabees

Trade	Frequency of Response	Percent
Builder	133	32.4
Steelworker	45	11.0
Construction Electrician	41	10.0
Utilitiesman	32	7.8
Equipment Operator	77	18.8
Construction Mechanic	65	15.9
Engineering Aide	17	4.1
Totals	410	100.0%

Table 6
Responses by Paygrade for Jobsite Seabees

Paygrade	Frequency of Response	Percent
E1	17	4.1
E2	57	13.9
E3	88	21.5
E4	133	32.4
E5	92	22.4
E6	23	5.6
Totals	410	100.0%

Table 7
Injury Frequency Rates for Jobsite Seabees (410 Workers)

Injury Type	Number	Injury Rate
First Aid Case	376	536.4
Medical Case	364	403.4
Lost Time Case	353	130.0

These injury frequency rates compare reasonably with those of all the Seabees surveyed, as shown in Table 4. It had been expected that these rates would be higher. When crew leaders are excluded leaving just the crew members, the injury frequency rates are : 625 for First Aid cases, 532 for Medical cases and 156 for Lost Time cases which are all higher than the overall rates, supporting the decision to focus on crew data. The crew leader data was retained since they are similar to working foremen on the jobsite.

Part C: Independent Factors Influencing Injury Rates

The three categories of independent variables or factors will now be analyzed in terms of their association with the injury frequency rates for jobsite workers. First, some general observations will be made regarding the personal type factors. Then the productivity and motivational factors proposed by Lieutenant Burns will be discussed. Correlation analysis and regression analysis were used to determine independent factor relationships with injury rates.

The two different command types were first compared for injury rates to detect any differences. The First Aid injury rate was virtually identical (534 for Battalions and 546 for the Units). However, for both Medical and Lost Time cases, the Units had higher injury rates than the Battalions (although neither were significant at the $p < .05$ level). These rates were 498 (Medical) and 169 (Lost Time) for the Units, and 381 (Medical) and 120 (Lost Time) for the Battalions. As the smaller Units have but one junior ranking commissioned officer in charge and

usually only three senior enlisted Seabees, there might be less command expertise and safety training compared to the Battalions with 20 officers, many chief petty officers and a full time senior enlisted Seabee devoted to safety. The safety programs are usually more formal and sophisticated in the Battalions.

The three injury rates were compared for the different trades to identify any trades with higher injury rates. These results are shown in Table 8:

Table 8
Injury Frequency Rate by Trade
for Jobsite Seabees

Trade	Number	Injury Frequency Rates		
		First Aid	Medical	Lost Time
Builder	105	618	516	141
Steelworker	37	467	563	183
Construction Electrician	33	761	510	182
Utilitiesman	27	749	505	132
Equipment Operator	53	510	186	126
Construction Mechanic	49	299	229	57
Engineering Aide	13	44	91	47
Total Average Rate	**317**	**536**	**403**	**130**

The results indicate that the steelworkers had the highest medical case and lost time injury rates among Seabees while the Construction Electricians had the highest First Aid injury rate. As could be expected, the Engineering Aides had the lowest rates for the three types of injuries. The steelworker trade could benefit from further research to pinpoint the nature of these injuries, e.g., do the injuries occur during welding operations, erecting steel above ground level, etc.

Table 9 shows the average injury rates for the jobsite Seabees based on the number of years that Seabee had been in the present command. The data appears to show that for the First Aid and Medical Case injuries, Seabees with less than one year in the command had higher injury rates. This was not the case with the Lost Time injury cases, where Seabees with less than one year and between two to three years in the command had similar rates which were higher than the group with one to two years in the command. The total average injury rates vary slightly from the total average injury rates in Table 8 because of missing responses to questions of trade and time in present command.

Table 9
Injury Frequency Rates
by Time at Present Command
for Jobsite Seabees

Time in Present Command	Average Injury Frequency Rates		
	First Aid	Medical	Lost Time
	307 cases	310 cases	309 cases
Less Than 1 Year	647	502	142
1 to 2 Years	349*	261*	103
2 to 3 Years	471	298	141
Over 3 Years	Not Applicable	Not Applicable	Not Applicable
Average Injury Rate	546	412	133

* denotes significance of $p < .05$ compared to Less Than 1 year rates

A similar breakdown is shown in Table 10 for the time each Seabee had been in the Navy:

Table 10
Injury Frequency Rates
by Time in the Navy
for Jobsite Seabees

Time in the Navy	Injury Frequency Rates		
	First Aid	Medical	Lost Time
	309 cases	312 cases	311 cases
Less Than 4 Years	673	611	166
4 to 10 Years	461	230*	92
More Than 10 Years	213*	176*	138
Average Injury Rate	540	410	132

* denotes significance of $p < .05$ compared to Less Than 4 Years rates

The results indicate a higher injury rate associated with the group who had less than four years in the Navy.

A more rigorous analysis by regression was performed on the two independent variables presented in Tables 9 and 10 to further test their relationship to injury rates. For all three injury cases, the most data that could be explained solely by these two variables was 3.2%. This indicates that the injury rates are complex variables, of which time in the command and time in the Navy play only a small part. Since regression analysis is based on normally distributed data, histograms were developed for the three injury types to verify the distribution. These histograms are shown in Appendix B. Since there are many 0 values (e.g. no injury of that type), the data is not normal, which helps to explain the weak results generated through the regression analysis.

Productivity and Motivational Factors

The 140 plus independent variables used in Lieutenant Burns' study were then tested against the dependent variables, the three types of injury rates. This testing was based on the non-parametric correlation method. This was done for First Aid, Medical Case and Lost Time injuries. Of the 140 plus variables, 11 relationships were statistically significant at the $p < .001$ level. The following variables were found to be related to better or lower injury frequency rates:

- Supervisor helps with personal problems
- Supervisor sets a good example on and off the job
- Supervisor praises workers
- Supervisor is respected by workers
- Worker would like to work for the Supervisor again
- Supervisor considers suggestions from crew
- Supervisor is a good motivator
- Worker is comfortable in work environment
- Daily safety lectures are effective
- Adequate assistance is provided by unit for personal problems
- Morale is generally good in work environment

Of the above variables seven relate to the supervisor. The correlation coefficients of these variables range from -0.18 to -0.22 with a $p < .001$. Based on this, and to simplify the display of the results, the responses for these seven supervisory variables were combined into a single variable: "Supervisor has good people skills".

This variable was created by summing the weighted mean injury rates for the seven variables and dividing by seven to find the mean injury rates of the new variable. This reduced the number of independent variables of interest to five in number. The following tables summarize the correlations found between the independent variables and the three injury rates. Appendix B contains the individual tables for the seven supervisory factors. The five possible responses (see page 12) were condensed into two groups. The first group combined the numerical responses 1, 2 and 3. This combined response covers answers from To a Very Little Extent, To a Little Extent and To Some Extent. Similarly, the numerical responses 4 and 5 were combined so the new response includes answers: To a Great Extent and To a Very Great Extent. The level of significance for the correlation of the independent variable with each injury rate is also presented. The entry of "n.s." (not significant) indicates that the level of significance is greater than .01.

Variable Tested: Supervisor has good people skills.

This variable combined the seven supervisor-related variables identified by the correlation analysis. Included are whether or not the supervisor: sets a good example to the workers, praises the workers, helps with personal problems, is respected by the workers, considers suggestions from the crew and is a good motivator and whether the workers would like to work for the supervisor again. Table 11 shows the correlation results.

Table 11
Correlation Between Supervisor Variable and Injury Frequency Rates

Responses	Valid Cases	Average Injury Rate		
		First Aid	Medical	Lost Time
Very little to Some Extent	140	639	449	164
Great to Very Great Extent	166	364	268	101
Injury Rate Correlates with Response Rank Correlation Coefficient		-0.23	-0.16	-0.02
Level Of Significance: $p < .001$, $p < .01$ or not significant (n.s.)		.001	.01	n.s.

The strongest correlation between the response and the injury rate and highest level of significance was found for the First Aid cases. The negative correlation coefficient indicates that as the numerical response increases from 1 to 5, (very little extent to a very great extent), the injury rate decreases. Both the correlation and level of significance decrease with increased injury severity. The results tend to indicate that as the Seabee's supervisor has better leadership traits, is concerned about the workers' welfare and is a positive role model, the injury rate, especially for minor injuries, decreases. This finding supports a growing number of studies in the civilian construction industry relating worker-supervisor relationship and jobsite injuries (Hinze and Gordon, 1979).

Variable Tested: Worker comfortable in work environment.

This variable summarized the opinion of each Seabee considering the comfort level of the environment in the work place. Table 12 shows the correlation between this variable and the injury rates.

Table 12
Correlation Between Worker Comfort Variable and Injury Frequency Rates

Responses	Valid Cases	Average Injury Rate		
		First Aid	Medical	Lost Time
Very little to Some Extent	175	661	402	156
Great to Very Great Extent	138	266	290	99
Injury Rate Correlates with Response Rank Correlation Coefficient		-0.27	-0.08	-0.03
Level Of Significance: $p < .001$, $p < .01$ or not significant (n.s.)		.001	n.s.	n.s.

The strongest correlation and level of significance were found with the First Aid injuries. Although the correlation coefficient was negative for both the Medical Case and Lost Time injuries, neither statistic was significant below .01. However, the finding is encouraging that as the Seabees are more comfortable, they have better safety records. Conversely, this finding might also point to the possibility that uneasiness about one's work environment might be a contributing factor to accident causation.

Variable Tested: Adequate assistance provided by the unit for personal problems.

This variable considered the help or assistance available from the command for the workers. The correlations to the injury rates are shown in Table 13.

Table 13
Correlation Between Assistance Variable and Injury Frequency Rates

Responses	Valid Cases	Average Injury Rate		
		First Aid	Medical	Lost Time
Very little to Some Extent	172	619	307	115
Great to Very Great Extent	127	335	328	131
Injury Rate Correlates with Response Rank Correlation Coefficient		-0.20	-0.03	+0.03
Level Of Significance: $p < .001$, $p < .01$ or not significant (n.s.)		.001	n.s.	n.s.

The above results show mixed findings regarding this variable and injury rates. The First Aid cases indicate that the Seabees who feel their command is taking care of them and is concerned about their personal welfare, have better safety records.

Variable Tested: Morale is generally good in work environment.

This variable was correlated with the injury rates to test if good morale had a good (in this case negative correlation) effect on the injury rates. Table 14 shows the results.

Table 14
Correlation Between Morale Variable and Injury Frequency Rates

Responses	Valid Cases	Average Injury Rate		
		First Aid	Medical	Lost Time
Very little to Some Extent	211	566	362	130
Great to Very Great Extent	99	326	292	135
Injury Rate Correlates with Response Rank Correlation Coefficient		-0.19	-0.04	-0.05
Level Of Significance: $p < .001$, $p < .01$ or not significant (n.s.)		.001	n.s.	n.s.

The finding for the First Aid cases supports the other results that a more positive work "environment" is associated with a lower frequency of minor injuries. Again, the results were less conclusive for the more serious injuries.

Variable Tested: Daily safety lectures are effective.

This correlation tested the relationship between the rating responses to whether or not safety lectures were helpful to the injury rates. The results are shown in Table 15.

Table 15
Correlation Between Safety Lecture Variable and Injury Frequency Rates

Responses	Valid Cases	Average Injury Rate		
		First Aid	Medical	Lost Time
Very little to Some Extent	165	588	426	141
Great to Very Great Extent	143	373	279	124
Injury Rate Correlates with Response Rank Correlation Coefficient		-0.16	-0.07	-0.12
Level Of Significance: $p < .001$, $p < .01$ or not significant (n.s.)		.001	n.s.	n.s.

The findings above support the earlier results presented in Part A of this Results Section that Seabees consider these daily lectures helpful and effective in preventing injuries.

These five variables that showed the strong correlation with the injury rate were analyzed by multiple linear regression to identify if any variable strongly influenced the injury rates. These results indicated only a weak influence of these individual variables on injury rates. The highest R Squared coefficient found was 0.07, or only 7% of the injury rate data could be explained by this analysis. This was for the variable "Supervisor considers suggestions from the crew". These weak results of the regression analysis indicate that many variables influence the injury rates of Seabees. The analysis was also limited by the information obtained from the original study designed to test productivity and motivational factors and only briefly surveyed safety issues. Thus, the focus of the variables was not on safety.

It is interesting to note that with the exception of the Daily Safety Lecture variable, the other variables all relate to the work-place environment or climate. These factors are external to the Seabee and can be controlled by the command's leadership. This finding is reinforced by reviewing the correlation coefficients of the factors internal to the workers. Since the correlations were strongest for the First Aid cases, the following variables and their correlations are presented in Table 16 for First Aid cases only:

Table 16
Correlation between First Aid Case Injury Rates and Internal Personal Factors

Internal Personal Factor	Rank Correlation Coefficient	Significant at $p < .05$?
Is your work consistent with your paygrade	-0.06	no
Are you happy with your rating (trade)	-0.07	no
Are you satisfied with quality of your work	+0.05	no
Do you have a sense of accomplishment	+0.02	no
Are you a self motivated person	-0.01	no
Do you set personal goals	-0.01	no
Do you achieve your goals	-0.02	no
Are you satisfied with your contributions to the unit	-0.04	no
Are you satisfied with the skills you have developed	-0.10	no

The results indicate that these internal self-generated factors do not play as important an role in injury rates compared to the external factors.

SECTION 5: SUMMARY AND RECOMMENDATIONS

This paper studied the safety related responses to a 1990 survey of Navy Seabees which analyzed the productivity and motivational factors that influenced this group of military construction workers. From the 618 cases in this sample, frequency rates for First Aid, Medical Case and Lost Time injuries were determined. Also analyzed were the responses to five questions regarding Seabees' opinions of safety issues in their commands. These responses were also tabulated by job description and construction trade to find trends in the data.

Further analysis was conducted on the responses from Seabees who actually perform physical labor on the jobsite. There were 410 cases in this sample. Injury frequency rates were determined for this group. The independent factors used in the original productivity and motivational factor study were analyzed for correlation with the injury frequency rates. Of more than 140 variables analyzed, 11 had correlations with injury rates that were significant at the level of $p < .001$. Of these 11, 10 were external, environmental type factors, including seven related specifically to the supervisor-worker relationship. These variables were also analyzed by regression analysis. This analysis showed that these variables had little individual influence on the injury rates, indicating that many varied factors influence the safety performance of Seabees. The personal, internal type factors analyzed showed little correlation to the injury rates.

Several other conclusions can be drawn from these findings. Overall, Seabees have a good safety environment. There is a high level of awareness for safety on the jobsite; there is also a high feeling of safety consciousness at the work place. Of the seven Seabee ratings, or trades, it appears that the Construction Electrician had the least sense of confidence in their safety environment.

From the analysis of the independent factors, the external, environmental factors showed a much stronger correlation to the injury rates than the internal, personal factors. This is important because the command has more control over the worker's environment than over a Seabee's personal feelings. The external factors identified all emphasize the importance or value of positive leadership and communication skills.

Specific recommendations resulting from this study are:

•Leadership training programs for crew leaders, Chief Petty Officers, and junior Officers, should stress the relationship identified in this study connecting the positive leadership skills already taught in the Navy and better jobsite safety.

•Include in the senior-level courses taught for new commanding officer, executive officers and operations officers in Battalions the influence of work-place environment and climate on jobsite safety.

•Conduct further review of individual Seabee ratings (trades), particularly the Construction Electrician and Steelworker ratings, to pinpoint areas requiring additional attention to decrease the injury rates and increase the level of safety knowledge and confidence of junior enlisted personnel.

BIBLIOGRAPHY

Burns, Timothy, W., LT, CEC, USN, "Motivational and Productivity Factors that Influence the Naval Construction Force", thesis , University of Washington, Department of Civil Engineering, 1990.

Hinze, Jimmie and Gordon, Francine, "Supervisor-Worker Relationship Affects Injury Rate", Journal of the Construction Division, AASCE, Vol. 105, No. C03, September, 1979.

Hinze, Jimmie and Burns, Timothy, "Job Factors That Influence Construction Worker Productivity", Construction Project Modelling and Productivity Proceedings of International Conference, Dubrovnik, 1991.

National Safety Council, Accident Facts, 1990 Edition.

U.S. Navy, Naval Facilities Engineering Command, Publication-315, Naval Construction Force Manual, 1983.

APPENDIX A

QUESTIONNAIRE

PRODUCTIVITY & MOTIVATIONAL QUESTIONNAIRE

PLEASE DO NOT SIGN YOUR NAME

INTRODUCTION: This questionnaire is to identify productivity and motivational factors that affect the Naval Construction Force (NCF). The responses will be analyzed to highlight particular areas of concern, and provide recommendations for improvement. Improving productivity and motivation includes providing adequate support and assistance to the work force and establishing a cooperative atmosphere among all levels of the NCF.

GENERAL INFORMATION
Please provide the following information about yourself:

1. Rate: _____ Paygrade: _____
   Time in Navy: _____ yrs Time at your present unit/command: _____ yrs
2. Position: [Check one answer]
   | | Project Manager | | Crew Leader
   | | Crew member | | Staff/Support
   | | Other, Please specify: _____

   Time at your present position: _____ yrs
3. Organization Type: [Check one answer]
   | | NMCB | | CBU
   | | Public Works | | Staff
   | | Other, Please specify: _____

PRODUCTIVITY: The following questions relate to factors which affect construction productivity. Circle the "rating" that best expresses your opinion or observations. If a question does not apply to you, then circle "N/A."

	TO A VERY LITTLE EXTENT	TO A LITTLE EXTENT	TO SOME EXTENT	TO A GREAT EXTENT	TO A VERY GREAT EXTENT	
A. The following questions relate to your supervisor/crew leader. Think of your supervisor or crew leader for a minute before answering the following questions.						
1. Is willing to help workers with personal problems?	1	2	3	4	5	N/A
2. Is friendly and easy to approach?	1	2	3	4	5	N/A
3. Sets a good example on and off the job?	1	2	3	4	5	N/A
4. Encourages teamwork?	1	2	3	4	5	N/A
5. Praises and recognizes workers for good performance?	1	2	3	4	5	N/A
6. Properly disciplines workers when necessary?	1	2	3	4	5	N/A
7. Shows favoritism to certain crew members?	1	2	3	4	5	N/A
8. Is respected by workers?	1	2	3	4	5	N/A
9. Is competent in day to day duties?	1	2	3	4	5	N/A
10. Would you like to work for him again?	1	2	3	4	5	N/A
11. Considers suggestions from crew?	1	2	3	4	5	N/A
12. Do you consider him a good leader?	1	2	3	4	5	N/A
B. The following questions relate to the members of your crew or fellow workers.						
1. They are friendly and easy to approach?	1	2	3	4	5	N/A
2. They work well together as a team?	1	2	3	4	5	N/A
3. Everyone pulls his own weight?	1	2	3	4	5	N/A
4. Does one worker's negative attitude affect the entire crew's performance?	1	2	3	4	5	N/A
5. Is there a lack of cooperation between your crew and other crews (subs) on your project?	1	2	3	4	5	N/A
6. Are your crew members competent in their ratings?	1	2	3	4	5	N/A

C. The following questions relate to the type of work you perform on a daily basis.

1. Do you generally work within your rating?	1	2	3	4	5	N/A
2. Are you happy with your rating?	1	2	3	4	5	N/A
3. Have you ever done work that you knew could be done better by another method?	1	2	3	4	5	N/A
4. Are you comfortable in your present work environment?	1	2	3	4	5	N/A
5. Are you satisfied with the quality of your work?	1	2	3	4	5	N/A
6. Does your work give you a sense of accomplishment?	1	2	3	4	5	N/A

7. What percent of your work time do you perform at your fullest potential? _____ percent of the time.
8. How many hours do you work each week? _____ hrs

D. To the best of your ability, please provide your personal opinions and observations to the following questions. If a question does not apply to you, then circle "N/A."

1. Does the location of your assignment (deployment site, duty station...) effect your productivity?	1	2	3	4	5	N/A
2. Are the proper tools for the job always available?	1	2	3	4	5	N/A
3. Are the available tools in adequate condition?	1	2	3	4	5	N/A
4. Are the available tools old fashioned or obsolete?	1	2	3	4	5	N/A
5. Are the construction materials of good quality?	1	2	3	4	5	N/A
6. Has your or your crew's performance been affected by poor quality materials?	1	2	3	4	5	N/A
7. Does the formal training (ie. schools) adequately prepare you for your assigned duties?	1	2	3	4	5	N/A
8. Do your current duties provide adequate on-the-job training?	1	2	3	4	5	N/A
9. Does the inspection program ensure quality work?	1	2	3	4	5	N/A
10. Has the performance of your crew ever been affected by a crew members substance abuse (drugs or alcohol)?	1	2	3	4	5	N/A
11. Has your performance ever been affected by substance abuse?	1	2	3	4	5	N/A
12. Is the proper equipment for the job available?	1	2	3	4	5	N/A
13. Is the available equipment in adequate condition?	1	2	3	4	5	N/A
14. Is the available equipment old fashioned or obsolete?	1	2	3	4	5	N/A
15. Has the use of poor quality equipment affected your crew's performance?	1	2	3	4	5	N/A
16. Has the use of computers had any affect on your performance?	1	2	3	4	5	N/A
17. Are computers effectively used within your unit/command?	1	2	3	4	5	N/A
18. Is adequate time set aside for planning and estimating of projects?	1	2	3	4	5	N/A
19. Are schedules usually followed?	1	2	3	4	5	N/A
20. Is it worth the time and effort to plan and estimate?	1	2	3	4	5	N/A
21. Are computers effectively used in the planning and estimating effort?	1	2	3	4	5	N/A
22. Are computers effectively used for project management during construction?	1	2	3	4	5	N/A
23. Should computers be used more in project planning and managing of projects?	1	2	3	4	5	N/A
24. Do safety regulations restrict your ability to work effectively?	1	2	3	4	5	N/A
25. Do you understand the need for safety awareness on the projects?	1	2	3	4	5	N/A
26. Do you feel that you work in a safety conscious work environment?	1	2	3	4	5	N/A
27. Are daily safety lectures affective?	1	2	3	4	5	N/A
28. Have you observed any major safety violations that were unreported?	1	2	3	4	5	N/A

29. Since you have been in your present unit/command, how many injuries have you received that:
    a. Required first aid treatment only? _____
    b. Required a doctor's attention? _____
    c. Were lost time accidents? _____

30. Has personal problems ever affected your crew's work?	1	2	3	4	5	N/A
31. If you had a personal problem, would you know where to go to seek help to resolve the problem?	1	2	3	4	5	N/A
32. Is adequate assistance provided by your command to resolve a member's personal problem?	1	2	3	4	5	N/A
33. Do you feel that your superiors are concerned about your personal problems?	1	2	3	4	5	N/A
34. Do you feel that the communication within your chain of command is effective?	1	2	3	4	5	N/A
35. Have you or your crew ever performed rework due to poor communications between crew and supervisor?	1	2	3	4	5	N/A
36. Is morale generally good in your work environment?	1	2	3	4	5	N/A
37. Has low morale ever affected your crew's work performance negatively?	1	2	3	4	5	N/A
38. Does family separation of your job affect your productivity?	1	2	3	4	5	N/A
39. Are you under a lot of stress in your work environment?	1	2	3	4	5	N/A
40. Is the productivity of your crew reduced due to stress?	1	2	3	4	5	N/A
41. Do you feel that the some constructions methods that are being used are outdated?	1	2	3	4	5	N/A
42. Are the quality of your project plans of good quality and are easy to understand?	1	2	3	4	5	N/A
43. Do the project plans have few errors (interferences, missing information...) that require major revisions?	1	2	3	4	5	N/A
44. Does a crew member's substandard physical fitness affect your crew's productivity?	1	2	3	4	5	N/A
45. Do any discriminatory remarks or actions by crew members affect your crew's productivity?	1	2	3	4	5	N/A
46. Would you like to increase your participation in the decision making process concerning your project?	1	2	3	4	5	N/A

E. The following is a list of factors that affect construction productivity. Please select the top <u>five factors</u> that most influence your work performance in a <u>positive</u> way, and rank in order of importance, (1-highest; 5-lowest).

	Supervisor		Planning and scheduling
	Type of work		Safety
	Weather		Personal problems
	Location		Chain of command communication
	Tools		Morale
	Materials		Family Separation
	Training		Stress
	Substance abuse		Construction Methods
	Equipment		Plans
	Computers		Discrimination
	Physical Fitness		Other, please specify : _____

<u>MOTIVATION</u>: The following questions relate to factors which affect a construction worker's motivation. <u>Motivation is the desire to satisfy your physical and emotional needs, by stimulating an active interest in your assigned task</u>.

A. To the best of your ability, please provide your personal opinions and observations to the following questions. If a question does not apply to you, then circle "N/A."

1. Does the opportunity for rewards (Letters of appreciation/commendation, medals, special liberty, etc...) improve your performance?	1	2	3	4	5	N/A

2. Do you feel that you are adequately recognized for contributions:
   a. By your superiors 1 2 3 4 5 N/A
   b. By your peers? 1 2 3 4 5 N/A
   c. By your subordinates? 1 2 3 4 5 N/A
3. Do your evaluations accurately reflect your performance? 1 2 3 4 5 N/A
4. If you received a less than average evaluation, would you try to improve your performance? 1 2 3 4 5 N/A
5. If you received an above average evaluation, would you work harder to maintain your performance level? 1 2 3 4 5 N/A
6. Is your supervisor a good motivator of personnel? 1 2 3 4 5 N/A
7. Do you tend to be a self-motivator? 1 2 3 4 5 N/A
7. Do you set personal goals for yourself? 1 2 3 4 5 N/A
8. Do you achieve your personal goals? 1 2 3 4 5 N/A
9. Do you know what your superiors expect of you? 1 2 3 4 5 N/A
10. Are you satisfied with your contribution to the command? 1 2 3 4 5 N/A
11. Are you learning a useful career skill at your present position? 1 2 3 4 5 N/A
12. Since you have been in the Naval Construction Force, have the duty assignments, training and experience that you received, been what you expected? 1 2 3 4 5 N/A
13. Do you consider the pay and benefits that you receive to be adequate compensation for your duties? 1 2 3 4 5 N/A
14. Do you enjoy your work? 1 2 3 4 5 N/A
15. Do you try to do a better job on some types of construction work than other types? 1 2 3 4 5 N/A
16. Is the type of work you perform meaningful? 1 2 3 4 5 N/A
17. Do you have pride in yourself as a member of the Navy? 1 2 3 4 5 N/A
18. Are you proud to be a member of your present command? 1 2 3 4 5 N/A
19. Are you proud to be a Seabee? 1 2 3 4 5 N/A
20. Are you satisfied with the advancement procedures? 1 2 3 4 5 N/A
21. Do you prefer to stay at your present paygrade? 1 2 3 4 5 N/A
22. Does the potential for advancement influence your performance? 1 2 3 4 5 N/A
23. Does the job security of being in the Navy influence your performance? 1 2 3 4 5 N/A
24. Do you feel that you have earned the respect from your:
   a. Superiors 1 2 3 4 5 N/A
   b. Peers 1 2 3 4 5 N/A
   c. Subordinates 1 2 3 4 5 N/A
25. Is the respect from others an influence on your performance? 1 2 3 4 5 N/A
26. How much longer do you expect to stay in the Navy? _____ yrs

B. The following is a list of factors that affect the motivation of construction workers. Please select the top five factors that most influence your work performance in a positive way, and rank in order of importance, (1-highest; 5-lowest).

	Money		Travel
	Rewards		Job satisfaction
	Benefits		Patriotism/camaraderie
	Recognition		Advancement
	Personal goals		Job security
	Training and education programs available		Respect
			Meaningful work
	On-the-Job Training		Other, please specify: _____

Thank you for the time and effort in answering these questions!

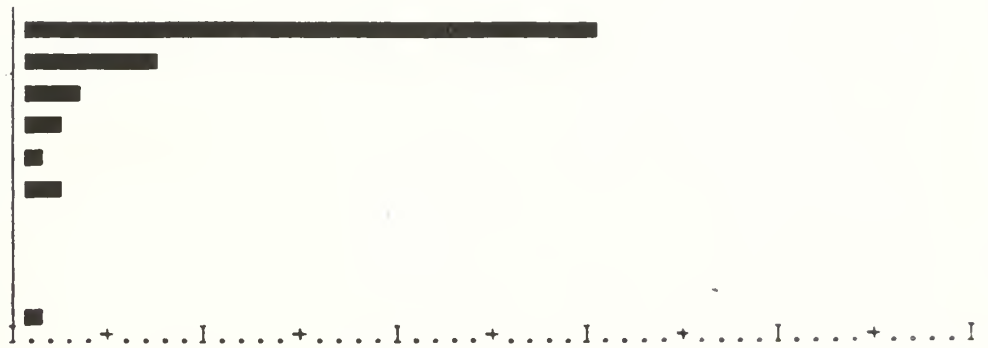
APPENDIX B

Histograms of Jobsite Seabees
Frequency of Injuries

MORE

AID Number of first aid injuries in past 3 y

ount	Midpoint	
242	.50	
58	1.50	
26	2.50	
17	3.50	
8	4.50	
12	5.50	
1	6.50	
1	7.50	
2	8.50	
5	9.50	



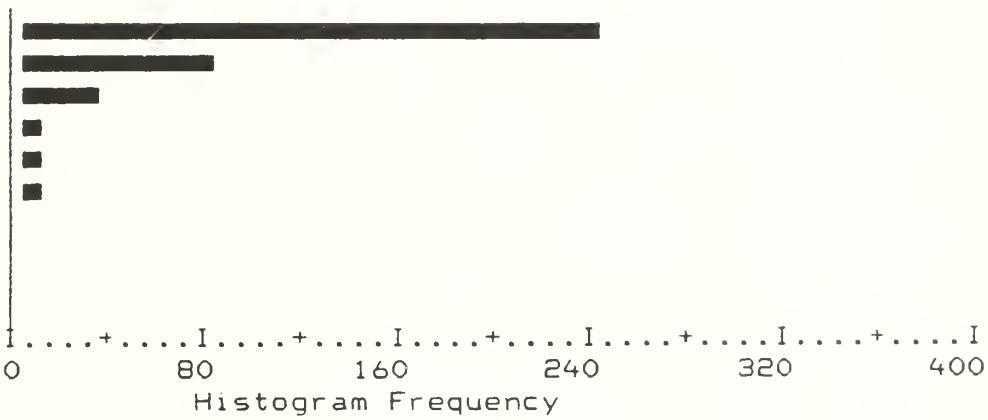
Cases 376 Missing Cases 34

MEDICAL CASES

MORE

Number of injuries needing doctor attent

unt	Midpoint
242	.50
81	1.50
29	2.50
10	3.50
7	4.50
5	5.50
1	6.50
1	7.50
0	8.50
3	9.50



Cases 379 Missing Cases 31

LOST TIME INJURIES

MORE

IME Number of lost time injuries in past 3 y

ount	Midpoint	
308	.50	
50	1.50	
12	2.50	
5	3.50	
0	4.50	
3	5.50	
0	6.50	
0	7.50	
1	[illegible]	

Histogram Frequency

Cases 379 Missing Cases 31

APPENDIX C

The following seven tables show the individual correlations between the particular supervisor-related variable and the three injury rates:

Variable Tested: Supervisor sets a good example on and off the job.

Responses	Valid Cases	Average Injury Rate		
		First Aid	Medical	Lost Time
Very little to Some Extent	130	687	522	199
Great to Very Great Extent	179	350	235	84
Injury Rate Correlates with Response Rank Correlation Coefficient		-0.19	-0.21	-0.12
Level Of Significance: $p < .001$, $p < .01$ or not significant (n.s.)		.001	.001	n.s.

Variable Tested: Supervisor praises workers.

Responses	Valid Cases	Average Injury Rate		
		First Aid	Medical	Lost Time
Very little to Some Extent	150	624	406	144
Great to Very Great Extent	157	367	309	116
Injury Rate Correlates with Response Rank Correlation Coefficient		-0.19	-0.21	-0.12
Level Of Significance: $p < .001$, $p < .01$ or not significant (n.s.)		.001	.001	n.s.

Variable Tested: Supervisor helps with personal problems.

Responses	Valid Cases	Average Injury Rate		
		First Aid	Medical	Lost Time
Very little to Some Extent	139	671	439	155
Great to Very Great Extent	166	355	271	92
Injury Rate Correlates with Response Rank Correlation Coefficient		-0.18	-0.11	-0.03
Level Of Significance: $p < .001$, $p < .01$ or not significant (n.s.)		.001	n.s.	n.s.

Variable Tested: Supervisor is respected by workers.

Responses	Valid Cases	Average Injury Rate		
		First Aid	Medical	Lost Time
Very little to Some Extent	141	624	419	162
Great to Very Great Extent	169	374	299	105
Injury Rate Correlates with Response Rank Correlation Coefficient		-0.20	-0.09	-0.06
Level Of Significance: $p < .001$, $p < .01$ or not significant (n.s.)		.001	n.s.	n.s.

Variable Tested: Worker would like to work for supervisor again.

Responses	Valid Cases	Average Injury Rate		
		First Aid	Medical	Lost Time
Very little to Some Extent	133	623	481	169
Great to Very Great Extent	175	387	254	103
Injury Rate Correlates with Response Rank Correlation Coefficient		-0.19	-0.14	-0.10
Level Of Significance: $p < .001$, $p < .01$ or not significant (n.s.)		.001	.01	n.s.

Variable Tested: Supervisor considers suggestions from crew.

Responses	Valid Cases	Average Injury Rate		
		First Aid	Medical	Lost Time
Very little to Some Extent	118	665	508	162
Great to Very Great Extent	187	362	251	115
Injury Rate Correlates with Response Rank Correlation Coefficient		-0.21	-0.15	-0.05
Level Of Significance: $p < .001$, $p < .01$ or not significant (n.s.)		.001	.01	n.s.

Variable Tested: Supervisor is a good motivator.

Responses	Valid Cases	Average Injury Rate		
		First Aid	Medical	Lost Time
Very little to Some Extent	172	599	398	160
Great to Very Great Extent	133	350	261	91
Injury Rate Correlates with Response Rank Correlation Coefficient		-0.18	-0.13	-0.03
Level Of Significance: $p < .001$, $p < .01$ or not significant (n.s.)		.001	n.s.	n.s.

APPENDIX D

SPSS Definition File

```
DATA LIST FILE= "c:\spss\thesis.dat" /Sampgrp 1-2 Number 3-5 Rate 6 Rank 7
Timenavy 8-9 Timeunit 10-11 Position 12 Timepos 13-14 Orgtype 15 Sperprob 17
Sfrneasy 18 Sexamjob 19 Sencteam 20 Spraise 21 Sdispl 22 Sfavor 23 Srespect 24
Scomp 25 Swork 26 Ssuggest 27 Sgoodldr 28 Cfrneasy 29 Cteam 30 Cpullwt 31
Cnegatt 32 Ccoop 33 Ccomp 34 Wrate 35 Whpyrate 36 Wmethod 37 Wworkenv 38
Wqual 39 Waccomp 40 Wperc 41-43 Whrsweek 44-45 assnmt 46 toolavl 47 tooladeq 48
toolold 49 matlgood 50 matlpoor 51 trnforml 52 trnojt 53 winspect 54 crwsubab 55
persubab 56 eqavail 57 eqadeq 58 eqold 59 eqcrew 60 compperf 61 compeff 62
petime 63 schfoll 64 peeff 65 pecomp 66 pmcomp 67 compuse 68 saferegs 69
safeawar 70 safeenv 71 safelect 72 safeviol 73 firstaid 74-75 doctor 76-77
losttime 78-79 / probcrew 1 probhelp 2 probasst 3 probsupr 4 commeff 5
commrewk 6 morgood 7 morcrew 8 famsep 9 stressen 10 stresscr 11 contmeth 12
plangood 13 planerr 14 physfit 15 discrim 16 decision 17 super 19 typework 20
weather 21 location 22 tools 23 material 24 training 25 subabuse 26 equip 27
computr 28 physfitn 29 plansch 30 safety 31 persprob 32 coccomm 33 morale 34
famsepr 35 stress 36 conmeth 37 plans 38 dscrim 39 other 40 / rewards 1
recsuper 2 recpeers 3 recsubor 4 evalperf 5 evalpoor 6 evalgood 7 supermot 8
selfmot 9 goalset 10 goalach 11 glexpect 12 satcontr 13 learnskl 14 trainexp 15
payben 16 enjoywrk 17 worktype 18 workmean 19 prdnavy 20 prdunit 21 prdseab 22
advsat 23 advstay 24 advpot 25 secjob 26 respsupr 27 resppeer 28 respsub 29
respothr 30 nvylgr 31-32 money 34 reward 35 benefits 36 recog 37 persgoal 38
train 39 ojtrain 40 travel 41 jobsat 42 patriot 43 advance 44 jobsec 45
respect 46 meanwork 47 otherm 48.
VARIABLE LABELS Sampgrp "Sample Group" / Number "Questionnaire Number"
/ Rate "Rate" / Rank "Paygrade" / Timenavy "Time in navy, yrs"
/ Timeunit "Time in unit, mos" / Position "Job title"
/ Timepos "Time in present position, mos" /Orgtype "Organization type"
/Sperprob "Supervisor helps with personal problems"
/Sfrneasy "Supervisor is friendly and easy to approach"
/Sexamjob "Supervisor sets a good example on and off the job"
/Sencteam "Supervisor encourages teamwork"
/Spraise "Supervisor praises workers"
/Sdispl "Supervisor properly disciplines workers"
/Sfavor "Supervisor shows favoritism to certain workers"
/Srespect "Supervisor is respected by workers"
/Scomp "Supervisor is competent in duties"
/Swork "Would like to work for supervisor again"
/Ssuggest "Supervisor considers suggestions from crew"
/Sgoodldr "Consider supervisor a good leader"
/Cfrneasy "Crew members are friendly and easy to approach"
/Cteam "Crew works as a team"
/Cpullwt "Crew members pull their own weight"
/Cnegatt "Negative attitude of one worker affects entire crew"
/Ccoop "Lack of cooperation between crews"
/Ccomp "Crew members are competent in their duties"
/Wrate "Work within your rate"
/Whpyrate "Happy with your rating"
/Wmethod "Complete any work which could have been done differently"
/Wworkenv "Comfortable in work environment"
/Wqual "Satisfied with your quality of work"
/Waccomp "Sense of accomplishment from work"
/Wperc "Percent of work done at your fullest potential"
/Whrsweek "Hours per week of work"
/assnmt "Work location effect your productivity"
/toolavl "Proper tools available"
/tooladeq "Tools in adequate condition"
/toolold "Tools old fashioned or obsolete"
/matlgood "Materials of good quality"
/matlpoor "Crew performance ever affected by poor quality materials"
/trnforml "Does formal training adequately prepare you for your duties"
/trnojt "Duties provide adequate on the job training"
/Winspect "Does inspection program ensure quality work"
/crwsubab "Crew performance ever affected by substance abuse"
/persubab "Your performance ever affected by substance abuse"
```

```
/eqavail "Proper equipment for the job available"
/eqadeq "Equipment in adequate condition"
/eqold "Equipment old fashioned or obsolete"
/eqcrew "Crew performance ever affected by poor quality equipment"
/compperf "Performance affected by use of computers"
/compeff "Computers are used effectively in unit"
/petime "Adequate time set aside for planning and estimating"
/schfoll "Schedules are usually followed"
/peeff "It is worth the time & effort to plan and estimate projects"
/pecomp "Computers are effectively used in planning and estimating"
/pmcomp "Computers are used effectively in project management"
/compuse "Use more computers in the P & E and proj mgt process"
/saferegs "Safety regs restrict ability to work effectively"
/safeawar "Understand the need for safety regs"
/safeenv "Work in a safe environment"
/safelect "Daily safety lectures are effective"
/safeviol "Observed safety violations that were unreported"
/firstaid "Number of first aid injuries in past 3 years"
/doctor "Number of injuries needing doctor attention in past 3 years"
/losttime "Number of lost time injuries in past 3 years"
/probcrew "Personal problems have affected crew performance"
/probhelp "Know where to go for help with personal problems"
/probasst "Adeq assistance is provided by unit for personal problems"
/probsupr "Superiors are concerned with your personal problems"
/commeff "Effective chain of command communication"
/commrewk "Rework has been performed due to poor communication"
/morgood "Morale is generally good in work environment"
/morcrew "Low morale has affected crew performance negatively"
/famsep "Family separation affects your performance"
/stressen "Under alot of stress in work environment"
/stresscr "Crew productivity has been reduced due to stress"
/contmeth "Outdated construction methods are being used"
/plangood "Project plans are of good quality"
/planerr "Project plans contain few errors that require revisions"
/physfit "Workers poor physical fitness affects crew productivity"
/discrim "Discriminatory remarks affect crew productivity"
/decision "Improve participation in decision making"
/super "Supervisor"
/typework "Type of work"
/weather "Weather"
/location "Location"
/tools " Tools"
/material "Material"
/training "Training"
/subabuse "Substance abuse"
/equip "Equipment"
/computr "Computer"
/physfitn "Physical Fitness"
/plansch "Planning and scheduling"
/safety "Safety"
/persprob "Personal problems"
/coccomm "Chain of command communications"
/morale "Morale"
/famsepr "Family separation"
/stress "Stress"
/conmeth "Construction methods"
/plans "Project plans"
/dscrim "Discrimination"
/other "Other productivity factors"
/rewards "Rewards influence performance"
/recsuper "Performance recognized by superiors"
/recpeers "Performance recognized by peers"
/recsubor "Performance recognized by subordinates"
/evalperf "Evals accurately reflect performance"
```

```
/evalpoor "Strive for improved performance due to a poor eval"
/evalgood "Strive to maintain or improve performance due to good eval"
/supermot "Supervisor is a good motivator"
/selfmot "Self motivating individual"
/goalset "Set personal goals"
/goalach "Achieve personal goals"
/glexpect "Know what is expected of your performance from superiors"
/satcontr "Satisfied with contributions to unit"
/learnskl "Learning a useful skill at present position"
/trainexp "Satisfied with skills developed"
/payben "Pay and benefits are adequate for work performed"
/enjoywrk "Enjoy your work"
/worktype "Work harder on some types of work than others"
/workmean "Perform meaningful work"
/prdnavy "Proud to be in the navy"
/prdunit "Proud to be in present unit"
/prdseab "Proud to be a Seabee"
/advsat "Satisfied with advancement procedures"
/advstay "Prefer to stay at present paygrade"
/advpot "Potential for advancement improves work performance"
/secjob "Job security influences performance"
/respsupr "Earned the respect of superiors"
/resppeer "Earned the respect of peers"
/respsub "Earned the respect of subordinates"
/respothr "Respect from other persons influence performance"
/nvylgr "How much longer do you expect to remain in the navy, yrs"
/money "Money"
/reward "Rewards"
/benefits "Benefits"
/recog "Recognition"
/persgoal "Personal goals"
/train "Training"
/ojtrain "On the job training"
/travel "Travel"
/jobsat "Job satisfaction"
/patriot "Patriotism and camaraderie"
/advance "Advancement"
/jobsec "Job security"
/respect "Respect"
/meanwork "Meaningful work"
/otherm "Other motivational factors".
VALUE LABELS Rate 1 "BU" 2 "SW" 3 "CE" 4 "UT" 5 "EO" 6 "CM" 7 "EA" 8 "Other"
/ Rank 1 "E1" 2 "E2" 3 "E3" 4 "E4" 5 "E5" 6 "E6" 7 "E7" 8 "E8" 9 "E9"
/ Position 1 "Project Manager" 2 "Crew Leader" 3 "Crew Member"
4 "Staff or Support" 5 "Other"
/ Orgtype 1  "NMCB" 2 "CBU" 3 "Public Works" 4 "Staff" 5 "Other"
/ Sperprob to Waccomp 1 "Very Little extent" 2 "Little Extent" 3 "Some extent"
4 "Great extent" 5 "Very great extent" 6 "N/A"
/ assnmt to safeviol 1 "Very little extent" 2 "Little extent" 3 "Some extent"
4 "Great extent" 5 "Very great extent" 6 "N/A"
/ probcrew to decision 1 "Very little extent" 2 "Little extent" 3 "Some extent"
4 "Great extent" 5 "Very great extent" 6 "N/A"
/ rewards to respothr 1 "Very little extent" 2 "Little extent" 3 "Some extent"
4 "Great extent" 5 "Very great extent" 6 "N/A".
MISSING VALUES Rank (0) / Rate Position Orgtype to Waccomp assnmt to safeviol
probcrew to respothr money to otherm (9) / Sampgrp Timenavy Timeunit Timepos
Whrsweek firstaid doctor losttime nvylgr (99) / Number Wperc (999).

* Productivity Efficiency Calculations.
IF (ORGTYPE EQ 1) AVGWK = 49.2.
IF (ORGTYPE EQ 2) AVGWK = 41.9.
COMPUTE PRODUCT = (WPERC * WHRSWEEK)/AVGWK.
IF (PRODUCT LT 55)                      PRODEFF = 1.
IF (PRODUCT GE 55 AND PRODUCT LT 85)  PRODEFF = 2.
```

```
IF (PRODUCT GE 85)                      PRODEFF = 3.
VALUE LABELS PRODEFF 1 "LOW" 2 "AVERAGE" 3 "HIGH".

RECODE SAFEREGS TO SAFEVIOL (6 = 9).
RECODE SPERPROB TO SAFEVIOL (2 = 1).
RECODE SPERPROB TO SAFEVIOL (3 = 1).
RECODE SPERPROB TO SAFEVIOL (4 = 2).
RECODE SPERPROB TO SAFEVIOL (5 = 2).
RECODE PROBCREW TO SUPERMOT (2 = 1).
RECODE PROBCREW TO SUPERMOT (3 = 1).
RECODE PROBCREW TO SUPERMOT (4 = 2).
RECODE PROBCREW TO SUPERMOT (5 = 2).

COMPUTE SUPER=(SPERPROB+SEXAMJOB+SPRAISE+SRESPECT+SSUGGEST+SUPERMOT+SWORK)/7.

IF (POSITION LT 2 OR POSITION GE 4) POSITGRP = 1.
IF (POSITION EQ 2 OR POSITION EQ 3) POSITGRP = 2.
VALUE LABELS  POSITGRP 1 "STAFF POSITION" 2 "JOBSITE WORKER".

IF (TIMEUNIT LE 3)                      TIMUGRP = 1.
IF (TIMEUNIT GT 3 AND TIMEUNIT LE 6)    TIMUGRP = 2.
IF (TIMEUNIT GT 6 AND TIMEUNIT LE 12)   TIMUGRP = 3.
IF (TIMEUNIT GT 12 AND TIMEUNIT LE 24) TIMUGRP = 4.
IF (TIMEUNIT GT 24 AND TIMEUNIT LE 36) TIMUGRP = 5.
IF (TIMEUNIT GT 36)                     TIMUGRP = 6.
VALUE LABELS TIMUGRP 1 "3 MONTHS OR LESS" 2 "4 TO 6 MONTHS" 3 "7 TO 12 MONTHS"
4 "13 TO 24 MONTHS" 5 "25 TO 36 MONTHS" 6 "GREATER THAN 36 MONTHS".

IF (TIMUGRP LE 3)                       YEARUNIT=1.
IF (TIMUGRP EQ 4)                       YEARUNIT=2.
IF (TIMUGRP EQ 5)                       YEARUNIT=3.
VALUE LABELS YEARUNIT 1 "LESS THAN 1 YEAR IN UNIT" 2 "1 TO 2 YEARS IN UNIT"
3 "2 TO 3 YEARS IN UNIT".

IF (TIMENAVY LE 1)                      TIMNGRP = 1.
IF (TIMENAVY GE 2 AND TIMENAVY LE 3)    TIMNGRP = 2.
IF (TIMENAVY GE 4 AND TIMENAVY LE 5)    TIMNGRP = 3.
IF (TIMENAVY GE 6 AND TIMENAVY LE 7)    TIMNGRP = 4.
IF (TIMENAVY GE 8 AND TIMENAVY LE 10)   TIMNGRP = 5.
IF (TIMENAVY GE 11 AND TIMENAVY LE 15) TIMNGRP = 6.
IF (TIMENAVY GE 16 AND TIMENAVY LE 20) TIMNGRP = 7.
IF (TIMENAVY GT 20)                     TIMNGRP = 8.
VALUE LABELS TIMNGRP 1 "1 YEAR OR LESS" 2 "2 TO 3 YEARS" 3 "4 TO 5 YEARS"
4 "6 TO 7 YEARS" 5 "8 TO 10 YEARS" 6 "11 TO 15 YEARS" 7 "16 TO 20 YEARS"
8 "GREATER THAN 20 YEARS".

IF (TIMNGRP LE 2)                       YEARNAVY=1.
IF (TIMNGRP GE 3 AND TIMNGRP LE 5)      YEARNAVY=2.
IF (TIMNGRP GE 6)                       YEARNAVY=3.
VALUE LABELS YEARNAVY 1 "LESS THAN 4 YEARS IN THE NAVY" 2 "4 TO 10 YEARS"
3 "MORE THAN 10 YEARS".

*Safety Factor Calculations - No. Injuries per 1,000 manhours.
* First Aid Injuries - SAFEFA.
COMPUTE SAFEFA = (FIRSTAID * 1000000)/((TIMEUNIT/12) * 48 * WHRSWEEK).
IF (SAFEFA GT 5000) SAFEFA = 5000.
* Doctor Required Injuries - SAFEDR.
COMPUTE SAFEDR = (DOCTOR * 1000000)/((TIMEUNIT/12) * 48 * WHRSWEEK).
IF (SAFEDR GT 5000) SAFEDR = 5000.
* Lost Time Injuries - SAFELT.
COMPUTE SAFELT = (LOSTTIME * 1000000)/((TIMEUNIT/12) * 48 * WHRSWEEK).

SELECT IF (RANK LE 6).
SELECT IF (POSITION GE 2 AND POSITION LE 3).
```

```
IF (FIRSTAID GT 0 AND FIRSTAID LT 99) FAINJURY = 1.
IF (FIRSTAID EQ 0)                    FAINJURY = 0.
IF (DOCTOR GT 0 AND DOCTOR LT 99)     DRINJURY = 1.
IF (DOCTOR EQ 0)                      DRINJURY = 0.
IF (LOSTTIME GT 0 AND LOSTTIME LT 99) LTINJURY = 1.
IF (LOSTTIME EQ 0)                    LTINJURY = 0.
```

Thesis
V162526 Van de Voorde
c.1 Work-related injury
frequency rates in the
Navy Seabees.

Thesis
V162526 Van de Voorde
c.1 Work-related injury
frequency rates in the
Navy Seabees.

DUDLEY KNOX LIBRARY
3 2768 00024489 1